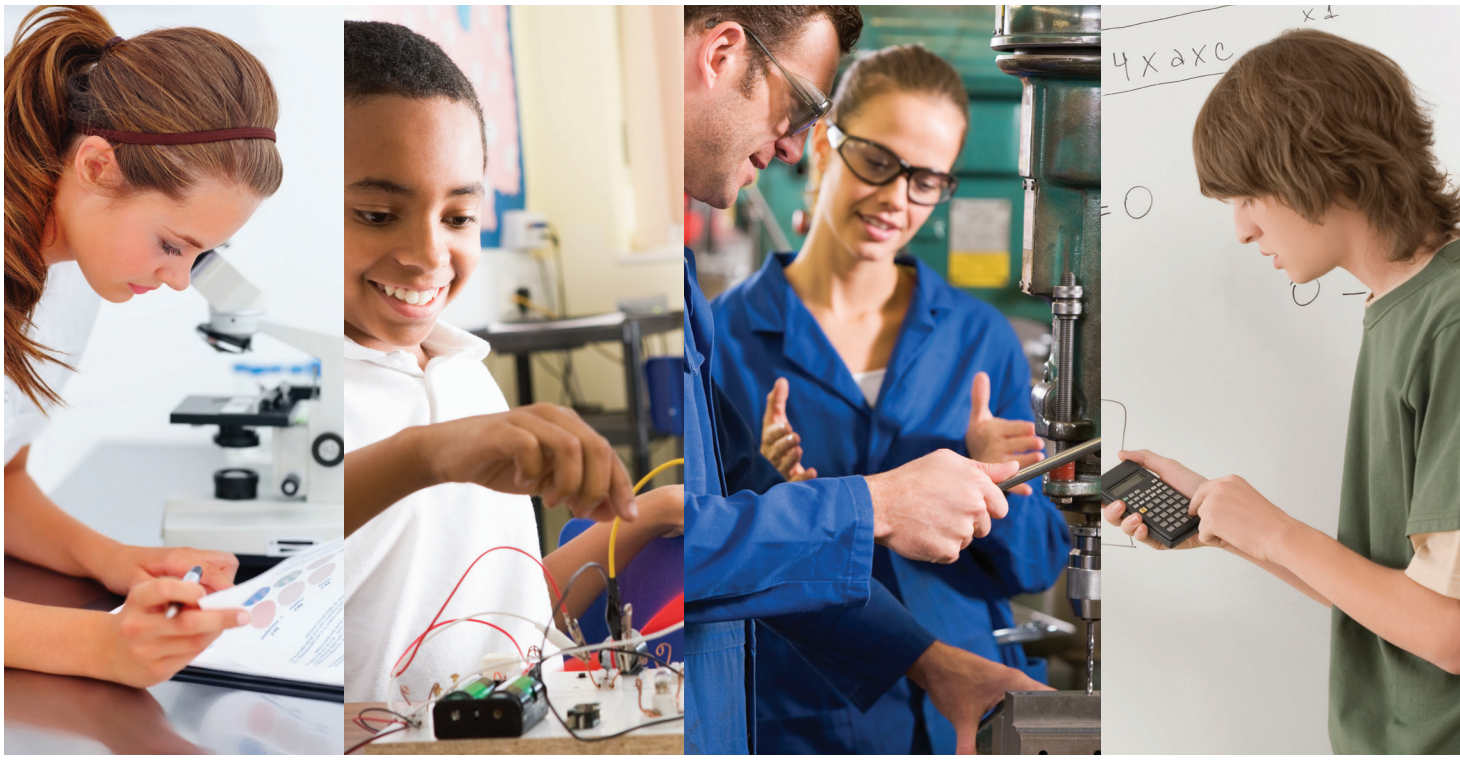
# NFER Thinks

What the evidence tells us

## Improving young people's engagement with science, technology, engineering and mathematics (STEM)



Skills shortages in STEM sectors represent a real threat to the UK's capacity for growth. Even in the current recessionary period, employers cannot find enough future employees suitably qualified in STEM to meet demand. Although young people value mathematics and science education, many do not study STEM subjects beyond GCSE and too few are currently inspired by STEM to pursue such choices beyond compulsory education. This paper, published to coincide with Science and Engineering Week 2013, presents NFER's research evidence about what works to encourage further engagement in, and take-up of, STEM subjects.

NFER calls on policymakers, schools, colleges, STEM employers, professional bodies and the research community to work together to ensure that successful strategies become more widespread.

## Why is engagement in STEM important?

The UK engineering and science industries are a vital element of the overall UK economy, with an approximate turnover of £257bn.[*1] The exact levels of demand for STEM skills are difficult to assess precisely.[2 3] Skills shortages in STEM sectors are, however, considered to represent a real threat to the UK's capacity for growth and at least one source estimates that around 82,000 engineers and technicians are needed just to deal with retirements up to 2016 and that 830,000 graduate-level science, engineering and technology professionals will be required by 2020.[4]

Even in the current recessionary period, employers cannot find enough future employees suitably qualified in STEM to meet demand,[5] which comes not only from employers seeking specific STEM expertise, but also from employers who value the capabilities of those qualified in STEM areas. Many young people do not study STEM subjects beyond GCSE[6] and, in relation to the earlier decision-making stages, a recent Department for Education study reports that, while the majority of 10 to 14-year-olds in England enjoy science, less than 17 per cent of these young people aspire to a STEM career.[2] By 2011, with the exception of further mathematics, the proportion of A-level pupils studying individual STEM subjects remained below that of 10 years previously.[7]

Although not enough young people are currently inspired by STEM (either as an academic or career route) to pursue such choices beyond compulsory level education, analysis of the Trends in International Mathematics and Science Study (TIMSS)[8] identifies that young people in England value mathematics and science education, and also understand the need for mathematics and science in life, employment and higher education. In addition, apprenticeships in England in engineering and advanced manufacturing have increased by more than 85 per cent since 2009/10.[6]

So, if young people value and understand the importance of STEM subjects, and more of them are now open to apprenticeships linked to STEM, what does NFER's research evidence tell us about what works to encourage further engagement in, and take-up of, STEM subjects?

## Positive steps: what works?

Discussions about STEM education are not new, and there has been significant activity in this area over the last decade. NFER has found many examples of good practice and has collected evidence about interventions that really make a difference and can be used to inform future developments. So, what do we know so far about the environments that support and encourage engagement in STEM?

From NFER's extensive body of research on STEM subjects since the Roberts Review in 2002,[9] there are several consistent messages that emerge from the evidence on the most beneficial features of activities and interventions in schools that improve young people's engagement in STEM.

### 1. Engage pupils at an early age and at key transition points

Although many pupils enjoy STEM subjects when they are younger, evidence shows that engagement with science subjects, in particular, decreases from the end of primary and throughout secondary education, as children and young people conceive of science as leading to a limited range of careers and as they perceive the STEM subjects to be difficult. That said, if they are enthused early, and are aware of the wealth and breadth of career – and earning – opportunities linked to STEM subjects, they are more likely to remain engaged. Stimulating interest in STEM subjects before times of choice and at key transition points can also increase engagement and encourage pupils to make subject choices that will help in pursuing a STEM career.[10 11]

### 2. Focus teaching on practical activities, set in real-life contexts and offer good quality enrichment and enhancement activities

Where STEM subjects are taught through practical activities set in real-world contexts, which allow pupils greater freedom to use their initiative and be creative, this can be particularly engaging. Young people regard the best teaching of STEM subjects to be that which makes links to everyday situations. This enables them to see the relevance of what they are studying.They come to understand the links between school science and exciting, cutting-edge developments such as CERN and Hubble. Good quality additional activities, such as taking pupils off timetable for a half or full day of STEM enrichment and enhancement activities, can also make an important contribution towards engaging pupils and may be particularly beneficial to provide a STEM 'boost' to pupils at key subject transition and decision points. Engaging pupils in such activities more frequently (through regular activities such as STEM Clubs or ongoing timetabled opportunities for engaging in STEM activities) will amplify and sustain any difference they make to pupils' interest in pursuing STEM study or careers in the future.[12 13 14]

### 3. Link teaching to careers in STEM

The research evidence shows that, where pupils have clear perceptions of the wide range of possible careers related to STEM subjects, and where their teachers and careers advisers have up-to-date knowledge of relevant careers, they are more likely to continue to study these subjects.[15] Links with industry and the public sector are essential, providing young people with real-life insights into STEM careers and the various routes in. It is important that these types of interactions are tailored to the local context and the needs of the pupil group. STEM Ambassador schemes play a crucial part in providing role models, mentoring and work placements that challenge stereotypes – about, for example, 'traditional engineering industries' and the professionals who work there. Wider engagement between education and employers provides young people with direct knowledge, experience and connections in particular careers, which translate into improved employment and learning outcomes.[11 13 14 16]

### 4. Make clear links across and between the STEM subjects

STEM is interdisciplinary, with STEM disciplines often being inextricably linked in the workplace, and this goes against the ways we generally teach subjects in secondary education in particular. Seeing the links is key, across and between the STEM subjects and to the world of work and careers. This can include mapping schemes of work to identify where teachers can make links between subjects within lessons or, on a more complex level, the delivery of STEM cross-curricular projects. Schools and colleges need to develop the interdisciplinary links so that they are embedded in the curriculum, building a strategy for STEM that goes beyond individual subjects to support achieving attainment or improvement targets and the raising of career aspirations in relation to STEM.[12]

* See separate appendix for endnotes.

### 5. Support teachers

All the evidence shows that enthusiastic and motivated staff with expert and up-to-date subject knowledge, as well as the ability to engage and inspire pupils in STEM subjects, offer the most effective means of encouraging and supporting pupils' learning. STEM teachers have a strong sense of teaching a specialist subject which needs to be supported by regular opportunities for updating their knowledge of their fast-moving subject field and of the careers it offers. Professional development with a focus on practical activities and real-life and current examples keeps lessons at the cutting edge, inspiring pupils to want to be part of these developments. It is the STEM teachers who build on the links with colleagues from industry to provide a coherent and stimulating vision of STEM opportunities who achieve more than exam success. They challenge gender stereotyping by presenting opportunities within science, technology, engineering and mathematics as being equally open to boys and girls.

## So what more can be done?

The Private Members' Bill on Science, Technology and Engineering currently before Parliament appears to have taken account of some of this evidence in its proposals: to place a duty on all schools (primary and secondary) to offer pupils the opportunities to understand careers in STEM subjects, and to be supported in doing so by advisory groups from industry and external bodies; and to require governing bodies of secondary level schools to include, for example, two local employers.

It could, however, go further. There is a need to maintain the momentum of this successful practice and create the conditions in which it translates to, and is embedded in, more schools, so that increased numbers of young people will be encouraged to choose to study STEM subjects and pursue STEM training and careers.

Policymakers, schools, colleges, STEM employers, professional bodies and the research community must work together to ensure that these successful strategies are supported, embedded and evidenced, and become more widespread across the education community.

#### Action in relation to teachers, lecturers, schools and colleges

We know what works in engaging young people in STEM and a holistic approach which combines a number, or all, of the elements below is at the heart of successful practice.

- **Does your school or college create an organisational culture that supports the implementation of such a holistic approach?**
- **As a teacher or lecturer of STEM subjects, do you feel empowered and supported to teach your pupils STEM subjects using these approaches?**

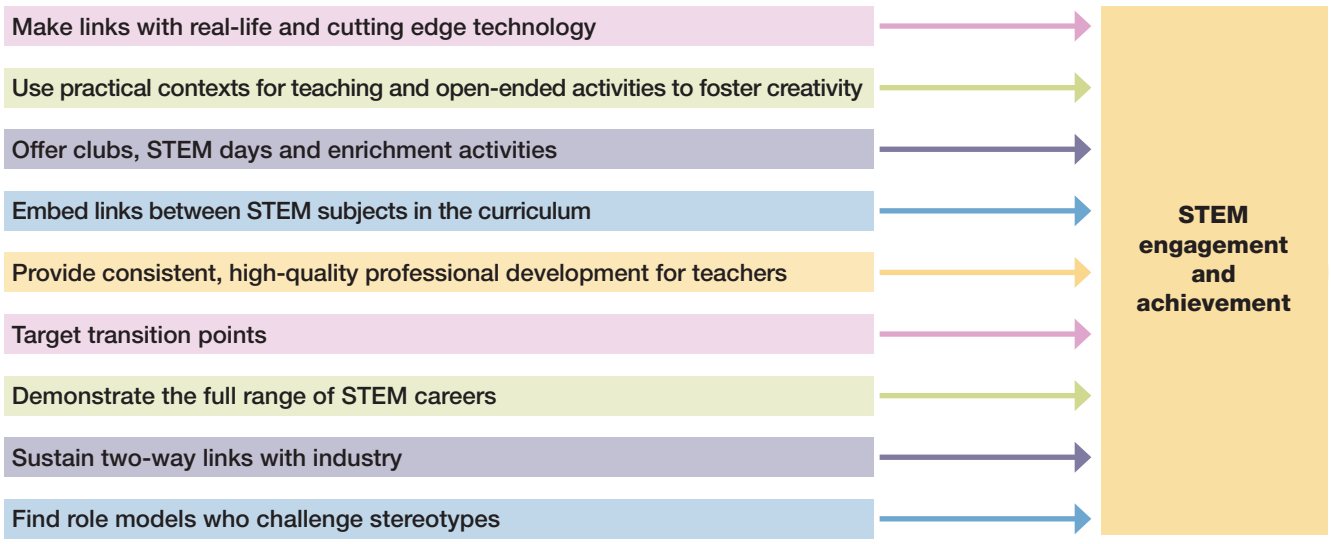
#### Action in relation to policymakers

The messages about what works in engaging young people in the STEM subjects have never been more important, not only for the future of industry and commerce, but also because of recent proposed changes in examinations. Revised GCSEs, which will contribute to the achievement of the English Baccalaureate, will include a more academic and rigorous curriculum core, and terminal rather than modular assessment. We need all pupils to be engaged by this academic core, in a way that will inspire them to succeed and to continue with their studies.[2]

As these new, more rigorous programmes of study and assessment models are developed, teachers must be free to devise meaningful teaching activities and tailor their teaching to ensure it is relevant and engaging. We know that engagement in STEM subjects increases when teaching and learning takes place through practical and applied activities. If the curriculum, assessment, reporting, accountability and examinations frameworks do not support these sorts of activities, the more traditional – and less engaging – approaches to teaching and learning will remain prevalent as teachers seek to support young people to achieve examination success.[17]

In addition, our research evidence strongly suggests that careers education and guidance should be provided earlier than Years 9–11 to encourage the uptake of STEM subjects. Schools must have access to the appropriate resources to provide this effectively.

- **How can the current policy changes support engaging approaches to teaching STEM subjects?**
- **How can future careers provision in schools be supported to encourage the uptake of STEM subjects whilst ensuring impartiality is maintained and that scarce resources are used effectively?**



### Action in relation to STEM employers

Given what we know about the value of employer involvement in supporting STEM in schools, continuing support for STEM Ambassador programmes is key, as is supporting small and medium enterprises (SMEs) to engage with education given their role in the economy and in recruiting young people.

All schools should be encouraged to take advantage of existing support and to make sustained connections with local employers.[12] [13]

**How can we raise the awareness of STEM employers further – with a focus on SMEs in particular – as to the benefits of engaging with education, with the aim of increasing the numbers who engage?**

### Action in relation to professional bodies and the educational research community

Although research and other studies have generated a wealth of evidence on what works in engaging young people in STEM, particularly in the decade since the Roberts Review of 2002, there remain significant gaps in data and knowledge of the sets of circumstances and influences which lead to young people ultimately choosing a career in the STEM sector.

In order to draw together the findings across this range of existing evidence (and facilitate more meta-reviews) there could be more consistency and commonality across the many individual studies conducted by both professional bodies and research organisations.

- **How can we better harness the evidence currently available to ensure we build a more coherent evidence base of what works in supporting young people to choose STEM study and careers?**
- **How can collaboration within the research community be increased? Is it possible to introduce a small number of standard questions which researchers use as a matter of routine and which build a national picture of what works over time?**


## Suzanne Straw

Suzanne Straw is Deputy Head of NFER's Centre for Evidence and Evaluation, with over 18 years' experience of undertaking research and evaluation studies relating to education, training and skills development. She leads NFER's work on the STEM agenda.

Since joining NFER in 2007, Suzanne has completed a wide range of evaluation studies related to engaging young people in STEM subjects and careers and to teachers' subject-specific continuing professional development (CPD). These have been undertaken for national government, regional agencies and STEM professional institutes and learned societies.

## Shona MacLeod

Shona MacLeod is a Senior Research Manager in NFER's Centre for Evidence and Evaluation with a wide range of experience, spanning over 14 years, in conducting research and evaluation on aspects of education. Since joining NFER in 2009, Shona has managed national studies in relation to STEM, which have focused on the implementation of interdisciplinary STEM projects and teachers' CPD. She currently manages NFER's evaluation of STEMNET's operations and impact.


## NFER

NFER is a charity with a reputation worldwide for providing independent and robust evidence for excellence in education and children's services. Our aim is to improve education and learning, and hence the lives of learners, by researching what is happening now. Our authoritative insights inform policy and practice, offering a unique perspective on today's educational challenges.

We work with an extensive network of organisations, all genuinely interested in making a difference to education and learners. Any surplus generated is reinvested in research projects to continue our work to improve the life chances of all learners from early years through to higher education.

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**National Foundation for Educational Research**
The Mere, Upton Park
Slough, Berks SL1 2DQ

T: 01753 574123
F: 01753 691632
E: enquiries@nfer.ac.uk
**www.nfer.ac.uk**

# Improving young people's engagement with STEM: Appendix

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